Specification:

Please replace pages 1-4 with the following amended pages 1-4: (the section titles are underlined to show that they are being added):

Measuring probe for measuring high frequencies ~~and method of producing said probe~~

Field of Invention

The invention relates to a measuring probe for measuring high frequencies ~~a detailed, in the preamble of claim 1~~.

Background Art

To test electronic circuits produced on wafers , for example for their ability to operate and their electrical characteristics, use is usually made of measuring probes which are applied mechanically to appropriate contact points on the electronic circuit to be tested. Electronic circuits of this kind which need to be tested are increasingly ~~ones,~~ circuits which generate or process high-frequency signals, which means that for the measuring probe there is an impedance of which due note needs to be taken. In other words, the measuring probe needs to have an impedance matched to the contact with the electrical circuit to be tested as otherwise, if there are mismatches, there will, as is generally known, be corresponding reflections which will have an unwanted effect on any measurement made or will make measurement totally impossible. There should not even be any change in impedance over the measuring probe itself because ~~jumps~~ changes in impedance of this kind also cause corresponding points of reflection.

Hence there is known from US 4 697 143 a measuring probe which, to allow a constant impedance to be obtained from a measuring cable to a contact point, has a co-planar conductor structure, with a signal conductor and a ground conductor being spaced away from one another in such ~~as~~ a way as to produce a desired constant impedance. However, this arrangement has the disadvantage that , due to the use of an aluminium oxide substrate , complicated shielding is required to avoid higher-order modes. Also, the measuring probe is complicated, laborious and cost-intensive to produce. Because of the relevant tolerances, not every measuring probe

produced meets the preset parameters and for this reason there is a high scrap rate in production, which makes the measuring probe even more expensive. In addition , ~~to this~~ the totally rigid arrangement of the co-planar conductor structure having ~~in particular~~ three or more conductors means ~~that~~ there is a problem in making contact. This is because, given the dimensions that exist on wafers and the corresponding tolerances to which the measuring probe, the contact points and the mechanical alignment of the measuring probe are subject, it is virtually impossible mechanically for all the conductors in the measuring probe's co-planar conductor structure to be precisely in the plane of the contact points when the probe is applied to the points. Hence certain conductors contact their particular contact point better and others contact theirs less satisfactorily or not at all.

From US 4 894 612 is known a measuring probe in which a dielectric is arranged over a complete length of a co-planar conductor structure. What is further disclosed is a measuring probe having strip lines where ends of the strip lines stand out resiliently from a substrate acting as a mounting.

The object of the invention is therefore to provide an improved measuring probe of the above kind, with simple and inexpensive volume production being achieved in this case with, at the same time, contact of a good standard.

Summary of the Invention

~~This object is achieved by a measuring probe of the above kind having the features detailed in the characterizing clause of claim 1. Advantageous embodiments of the invention are detailed in the independent claims in this case.~~

One aspect of the present invention relates to a measuring probe for measuring high frequencies that includes a contact for contacting planar structures and a co-axial cable end for connection to a co-axial cable. A co-planar conductor structure having at least two conductors is arranged between the contact end and the co-axial cable end. A solid dielectric mounts the co-planar conductor structure. The dielectric is arranged on the co-planar conductor structure and on at least one side of the co-planar conductor structure in a central section of the probe so the

dielectric is between and spaced from the co-axial cable end and the contact end. Each conductor in the co-planar conductor structure includes a portion formed to be individually free in space and resilient in relation to the dielectric. A respective gap is formed between each pair of conductors in the co-planar conductor structure from the co-axial cable end to the contact end in such a way that a constant characteristic impedance is obtained from the co-axial cable end to the contact end.

~~In a measuring probe of the above kind, provision is made in accordance with the invention for the dielectric to be arranged on a least one side and in particular on both sides of the co-planar conductor structure in a central section between, and spaced away from in the direction of propagation the co-axial cable end and the contact end, in such a way that each conductor in the co-planar conductor structure is formed to be individually free in space and resilient in relation to the dielectric acting as their mounting between the dielectric and the contact end a respective gap being formed between each pair of conductors in the co-planar conductor structure from the co- cable end to the contact end in such a way that a contact characteristic impedance is obtained from the co-axial cable end to the contact end.~~

~~This has the advantage that it provides an inexpensive and accurate measuring probe which can even be produced in volume t and whose impedance is controlled, thus giving~~ A measuring probe with the foregoing features is relatively inexpensive and accurate even though it can be produced in high volume. The probe impedance can be controlled, so there are low reflections when contact is made with the planar structure for measuring purposes. The arrangement according to the invention is notable for operating frequencies of up to 40 to 60 GHz, with impedance being substantially free of dispersion, i.e. independent of the operating frequency, over the whole of the co-planar conductor structure due to the design according to the invention. The freely resilient arrangement of the conductors in the co-planar conductor structure between the dielectric and the co-axial cable end ensures ~~that there is contact of~~ a high standard of contact between all the conductors in the co-planar conductor structure and the corresponding contact points on a device to be tested ~~the~~ . The standard of the contact is not ~~being~~ affected by the measuring probe being tilted when ~~it~~ the probe is applied to the contact points.

Another aspect of the invention concerns apparatus for coupling an electromagnetic wave between first co-planar, spaced planar electrical conductors and a pair of spaced co-axial electrical conductors. The apparatus comprises N second co-planar, planar conductors having first and second ends respectively adapted to be connected to the first conductors and the co-axial conductors, where N is an integer greater than one. The second N conductors are transversely spaced from each other throughout the length thereof between the first and second ends. The transverse spacing between the second N conductors is different in different portions of the length thereof between the first and second ends. A solid dielectric is electromagnetically coupled with the portions of the second conductors that have the greatest transverse spacing from each other. The solid dielectric and the transverse spacing are such that a constant characteristic impedance is obtained between the first and second ends.

The solid dielectric and the portions of the second conductors having the greatest transverse spacing are preferably located remotely from the first and second ends.

Preferably, the apparatus is a contact probe and the portions of the second conductors having the greatest transverse separation and the solid dielectric are fixedly connected, with portions of the second conductors between the portion having the greatest separation and the first end being individually free in space and resilient in relation to the solid dielectric so that the second conductors at the first end form contact fingers that are relatively free in space to contact against ends of the first conductors.

Preferably, N is 3 and a central one of the second conductors is adapted to be connected to the center conductor of the co-axial conductors, and an outer pair of the second conductors is adapted to be connected to the outer conductor of the co-axial conductors.

In one embodiment, the transverse spacing between the second conductors in the vicinity of the first end of the second conductors is tapered, preferably such that the spacing is less at the first end than at a location of the second conductors longitudinally spaced from the first end.

In another embodiment, the tapering is constant between the first end and the portions of the second conductors having the greatest separation. The dielectric is preferably metallised over its full area on a side thereof remote from the face of the dielectric that contacts the co-planar conductor structure.

In a preferred embodiment, the dielectric is in the form of at least one block of quartz.

To provide a secure connection between the co-planar conductor structure and the block of dielectric, the ~~latter has, on a side where~~ dielectric block has, on its side that it is connected to the co-planar structure, a metal coating which substantially coincides in shape with the ~~latter~~ co-planar structure.

To suppress higher-order modes above the desired operating frequency the dielectric is metallised over its full area on a side remote from the co-planar conductor structure. This also produces a closed, shielded structure in the ~~region~~ vicinity of the dielectric.

For certain applications, a planar circuit , preferably ~~and in particular~~ an electrical or electronic active circuit , or at least one active circuit element , is arranged at the co-axial cable end. This puts the additional circuit or the additional circuit element in the immediate vicinity of contacts between the measuring probe and a circuit to be tested at the contact end of the measuring probe.

The invention will be explained in detail below by reference to the drawings. ~~In the drawings:~~

Brief Description of the Drawing

Fig. 1 is a perspective view of a first preferred embodiment of a measuring probe according to the invention,

Fig. 2 is a perspective view of a second preferred embodiment of a measuring probe according to the invention,

Fig. 3 is a plan view of a third preferred embodiment of measuring probe according to the invention,

Figs. 4 to 7 ~~show~~ are drawings of successive steps ~~in~~ of a method ~~according to the invention~~ for making probes of the types illustrated in Figs. 1-3, and

Fig. 8 is an S parameter plot from a simulation calculation for a measuring probe according to the invention.

Detailed Description of the Drawing

The first preferred embodiment of a measuring probe 100 according to the invention which is shown in Fig. 1 comprises a co-planar conductor structure 10 having a signal conductor 12 in the centre and two ground conductors 14 arranged in co-planar positions adjacent to the signal conductor 12. A predetermined gap 16 is formed between signal conductor 12 and a given ground conductor 14. The co-planar conductor structure 10 extends from a co-axial cable end 18 to a contact end 20 and the gap 16 is formed over the entire length of the co-planar conductor structure 10 in such a way as to produce a constant predetermined characteristic impedance. At the co-axial cable end 18, the co-planar conductor structure 18 is connected to a co-axial cable 22, with the signal conductor 12 making contact with a centre conductor 24 and the ground conductors 14 with an outer conductor 26 of the co-axial cable.